Moran Square, Fitchburg, MA
Low Carbon Historic Retrofit
Rees Larkin Development, TAT, Biome Studio, Petersen Engineering, Building Science Corporation, New Frameworks, Advanced Building Analysis, Keith Construction
Global CO2 Emission by Sector

- Building Operations 28%
- Building Materials & Construction 11%
- Industry 30%
- Transportation 22%
- Other 9%

- Architecture 2030
Decarbonize Moran Square

1. leveraging embodied carbon – existing building
2. operational carbon – PHIUS Passive House & solar
3. low carbon & carbon storing materials
44 units of affordable housing
carbon storing materials
“Embodied Carbon (eCO2e) is the sum impact of all the greenhouse gas emissions attributed to the MATERIALS throughout their life cycle.”
CARBON IMPACTS OF INSULATION

kgCO₂ represents R-20 at 234 m²

6,735 kgCO₂ emitted

EXTRUDED POLYSTYRENE (XPS)

CLOSED CELL SPRAYFOAM (HFC)

CLOSED CELL SPRAYFOAM (HFO)

EXPANDED POLYSTYRENE (EPS)

MINERAL WOOL BATT

FIBERGLASS BATT

DENIM BATT

WOOL

DENSE PACK CELLULOSE

CORK

HEMPCRETE

STRAW BALE

-7,437 kgCO₂ embodied

INGREDIENTS VARY

1. MATERIAL EXTRACTION

2. MANUFACTURING

EMISSIONS INFLUENCED LARGELY BY SOURCE ENERGY TYPE

3. TRANSIT

4. USE

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Carbon impacts data source: Builders for Climate Action - 2019 White Paper
"Low-Rise Buildings as a Climate Change Solution", Chris Magwood, 2019;
plant-based, carbon-storing building materials

Carbon storing materials palette

Timber  Wood Fiber Board  Cork  ReWall  Waste Textiles
Cellulose  Straw  Mycelium  Rice Hulls  Bamboo / BamCore
Coconut Coir  Hemp OSB  + more

and no red list chemicals!
Our sources of data:

- Industry average EPD for North America
- Product specific EPD for North America
- Industry average EPD for Europe
- Product specific EPD for Europe
- LCA data from peer reviewed sources
- ICE database
concrete!

8% of global greenhouse gas emissions
Use Less Materials!
Low Carbon Materials

1. **Concrete** – Increase Fly Ash and Reduce Portland

2. **Insulation** – Cellulose, Mineral Wool, Eco-Fiberglass, Glavel, Low HFO Foam

3. **Studs** - Wood Instead of Steel

4. **Flooring** – Reuse wood, Marmoleum, Interface LVT (zero carbon)

5. **Sheetrock** - Ecosmart
cut operational carbon!
PHIUS Passive House + solar
Passive House (PHIUS)

Continuous insulation without thermal bridging

Airtight

High performance windows & doors

Heat & moisture-recovery ventilation

Minimal space conditioning
AIR BARRIER
Passive House Air Barrier
Federal Historic Tax Credits

Moran Square = Good Candidate for Passive House

1. simple architecture
2. simple windows
3. limited interior exposed brick
National Park Service Standards and Guidelines

1. Windows!! - Casement to Meet Air Infiltration Goals
2. Wall Section Depth
3. Exposed Brick
4. Thermal Bridges
5. Nothing Visible from the Exterior
6. New Building – Brick Facade
Windows!
Simulated Double Hung Casement Windows! – U < .14

- diagram from Zola
Original Historic Window

Simulated Double Hung Casement Window
Solar Heat Gain Coefficient – Too Reflective!

Better = SHGC .49
Too Bulky

Installation 1

Installation 2
Too Bulky – Meeting Rail Profile

Original Historic Window

Simulated Double Hung Casement Window
Meeting Rail

Mockup 1

Original Proposal to NPS
wall section depth
Firehouse – Exposed Brick
Firehouse existing conditions – 2nd floor
Firehouse Attic

~ 5'6”
Brick
4”
6 1/8 – 6 ¾” from brick to new wall surface

Harper Building

Plaster Lath & Strapping
2 1/8”
2 ¼”

new wall surface
Foam-Free Insulation and Air Sealing
Cold Climate Risks

- Freeze-thaw (reduced drying)
- Air leakage condensation on interior face of masonry
- Rot / corrosion of embedded elements
- Covering interior → less early warning of damage problems in the wall
Masonry Interior Insulation Retrofit Assemblies

- **Closed-cell spray foam**
- **Semi-rigid mineral fiber board**

Climate Zone 4 or Warmer
Figure 167: Stud wall with cavity insulation and service cavity (BSI-105)
Figure 163: Conceptual drawing of mineral fiber and cellulose insulation option

- Interior gypsum board, latex paint interior
- 2x4 stud frame wall with cellulose insulation
- Variable-perm vapor retarder (CertainTeed MemBrain or equal)
- 2" semi-rigid mineral fiber (Rockwool ROCKBOARD 40 @ R-4.2 per inch)
- Vapor semi-permeable fluid-applied air and water control membrane
Solar
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Reduction</td>
<td>Historic Building Reuse</td>
<td>Achieved</td>
</tr>
<tr>
<td>Energy</td>
<td>Passive House + Solar PV</td>
<td>Achieved</td>
</tr>
<tr>
<td>Concrete</td>
<td>Reduce Portland, Increase Fly Ash</td>
<td>Achieved</td>
</tr>
<tr>
<td>Siding on new building</td>
<td>FSC Wood, no brick/no fiber cement</td>
<td>National Park Service Requirement</td>
</tr>
</tbody>
</table>
| Insulation                | Cellulose, eco-fiberglass, mineral wool, Glavel                             | Wall section = cellulose and fiberglass.  
Demising walls (acoustic) = eco-fiberglass.  
Under slab = Glavel.  
Ceiling of parking garage (compromise!) – low HFO foam  
No XPS!!!                  |
| Dimensional framing       | Wood instead of steel                                                        | ???        |
| Windows                   | Wood                                                                         | Some       |
| Flooring                  |                                                                              | No carpet!  
Reuse of some existing wood flooring.  
Forbo marmoleum.  
LVT (Interface says carbon neutral) |
| Countertops               | Wilsonart and Formica                                                        | Greenguard and recycled content |
| Sheetrock                 | EcoSmart                                                                     | ???        |
| Cabinets                  | FSC                                                                           | No good options. Using wood. |
| Wood                      | FSC                                                                           | No         |
Architect Brad Benke studied the impacts of brick façade systems and discovered that five functionally equivalent wall types had very different impacts. Thin brick on metal studs, shown at the far right, reduced embodied carbon 58% compared with a baseline wall system (thin brick with precast concrete).

Image: LMN Architects

Brick

Greenleaf (31% recycled content)

Thin Brick
Team Coordination and CoVid

Passive House - Yes

Low Carbon Materials - Huh? Where’s the checklist, points, certification?